



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

LOESS WITH HORIZONTAL SHEARING PLANES.

WHILE engaged in field work on Pottawattamie county for the Iowa Geological Survey in the summer of 1900, a peculiar structure in the loess came under my observation. This appeared to me so unique as to merit special notice.

The loess in Pottawattamie county is of the usual western type. It is lighter in color, slightly coarser, and of a more open texture than the loess in the eastern part of Iowa and in Illinois. It is also heavier, and contains a greater number of fossils than the latter. In the east bluffs of the Missouri river it averages not far from a hundred feet in thickness in this county, and occasionally this measure is exceeded. It frequently contains fossils. In the north part of the county, and sometimes also in the south, it rests on a somewhat darker and more ferruginous deposit. This is similar to loess in appearance, but is less calcareous, in places sparsely pebbly, and much less pervious to water, owing to the presence among its particles of an exceedingly fine and silty ochreous ingredient. It resembles in general the "gumbo" which has been described by Leverett¹ as occurring under the loess in some parts of Iowa, Missouri, and Illinois. This gumbo changes downward into the old leached and weathered upper part of the underlying till. Its upper surface is sometimes marked by an old soil horizon.

The peculiar structure noted in the loess involves the horizon where the two formations just described come into contact; the level where the gumbo changes, gradually or abruptly, upward into loess. Perhaps it would be more accurate to say that it affects the top of the gumbo as well as the base of the loess.

Examining closely one day the lower part of the loess in an excavation southeast from the Pierce Street School in Council Bluffs (near the corner of Voorhees street and Franklin avenue), the lower part of the embankment was seen to be laminated, and

¹ *U. S. Geol. Surv., Mon. XXXVIII*, p. 28.

the lamination was apparently quite unlike that which results from sedimentation. To better ascertain the nature of this lamination a block of considerable size was detached and gently split by fracture along the planes of the laminæ. To my astonishment it revealed a surface strongly reminding of some gently fluted

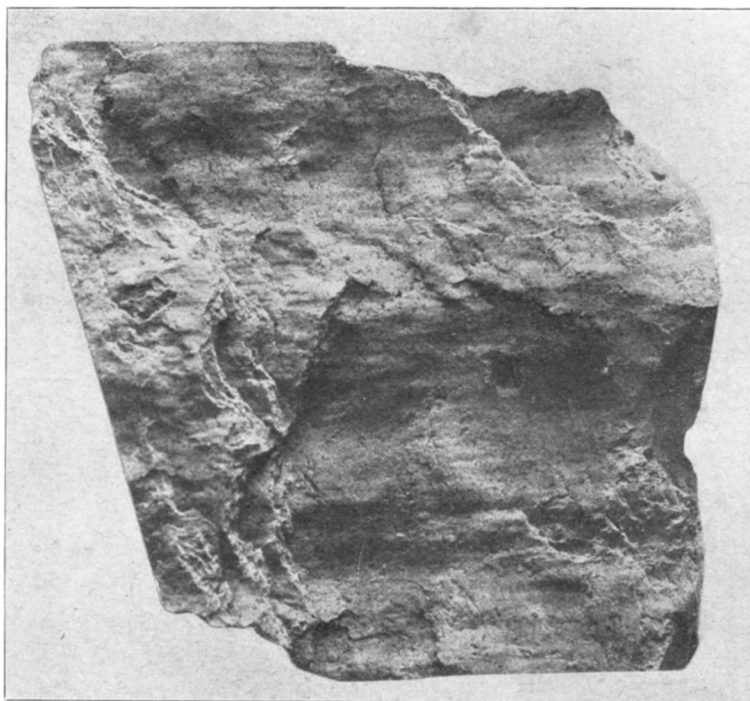


FIG. 1.—Fluted shearing-planes in the loess in Pottawattamie county, Iowa (slightly reduced).

ice-scorings (see Fig. 1). I replaced the lower half of the block and took the bearings, south 60° west and north 60° east. Repeating the observation at several points along the embankment, I found the fluted ridges to pursue strictly the same trend at all places. I also noticed that this trend lay neither in the direction of a tangent nor of a radius to the periphery of the hill in which the excavation was made.

In the continuation of my work in the north half of the county this lamination was observed at a number of other places as follows :

1. *Norwalk township*, in the west bank of the wagon road one-fourth of a mile south of the northwest corner of Section 9. Direction of flutings, S. 65° W.—N. 65° E.

2. *James township*, near the wagon road one-fourth of a mile south of the northwest corner of Section 12. Direction of flutings, S. 20° W.—N. 20° E.

3. *Boomer township*, in the left bank of the wagon road in the north bluff of Pigeon Creek, near the center of the northwest quarter of Section 33. Direction of flutings, S. 70° W.—N. 70° E.

4. *Neola township*, in the bank of the wagon road leading up the hill near the center of Section 24 (on the west border of the town of Neola). Direction of flutings varying from S. 70° W.—N. 70° E. to S. 78° W.—N. 78° E.

5. *Minden township*, in the wagon road near the center of Section 10. Direction of flutings, W. 15° N.—E. 15° S. Also in the north bank of the deep cut of the Chicago, Rock Island & Pacific Railroad about one-fourth of a mile north of the center of Section 21. Direction of flutings, W. 5° N.—E. 5° S. Also in the ditch on the north side of the embankment of the Chicago, Rock Island & Pacific Railroad about one-fourth of a mile east of the northwest corner of Section 19. Direction of flutings, W. 8° N.—E. 8° S. Also in both banks of the railroad cut just south of the bridge across Mosquito Creek in Section 19, east of the town of Neola. Direction of flutings, W. 10° N.—E. 10° S.

6. *Pleasant township*, in the west bank of the Chicago, Rock Island & Pacific Railroad, in the southeast quarter of Section 5. Direction of the flutings, S. 58° W.—N. 58° E. Also in the north bank of the wagon road near the southeast corner of Section 12, and again nearly one mile farther west along the same road. Direction of flutings in both places, S. 78° W.—N. 78° E.

7. *Knox township*, in the west bank of the wagon road just east of the bridge across Biddle Creek, north of the southeast corner of Section 2. Direction of flutings, N. 45° W.—S. 45° E.

8. *Layton township*, in the deep cut of the Chicago, Rock Island & Pacific Railroad, near the west line of Section 13. Direction of flutings, S. 14° W.—N. 14° E.

As seen at these points the laminæ vary from one-eleventh to one-thirtieth inch in thickness, one-sixteenth inch being the most common. There was nowhere any difference in the texture of the material of which they were composed. They are marked off from each other by sharply defined planes, along

which the mass may be caused to split more or less readily. Occasionally layer after layer may be peeled off by the insertion of the blade of a knife in the seams which separate them. In one instance the surfaces exposed in this way were smoothened, as it were, by a thin film of dark ferruginous material which evidently had been deposited by infiltration along the seams separating the layers. The flutings are straight, compound folds in the layers. When the latter are viewed in a section vertical to the trend of the flutings, they appear as parallel, very shallow waves an inch or two in width. On these there is a second parallel system of small folds only about an eighth of an inch wide. These also have a very shallow depth, which barely renders them perceptible. Occasionally the layers wedge out, the seams separating them running together. To one familiar with the appearance of ripples and ripple marks, a glance at the surface of these layers in the loess suffices to show that they have nothing in common with the former. The ridges of ripple marks are never straight. Their opposite slopes are regularly unsymmetrical, always steeper in one and the same direction for successive waves. There is no second series of smaller waves parallel with the larger ones. Ripples are also somewhat uniform in size. They are invariably associated with sorting of coarse and fine materials. In vertical section the flowing curves of ripples constantly intersect. None of these characteristics appear here. The folds and flutings in the loess are straight, it might be said rigidly straight. The slopes of the folds are symmetrical, or irregularly unsymmetrical. There is also a considerable variation in size of the folds. As stated before, there is no sorting by which coarse materials have been separated from the fine. The partings between the layers tend to run parallel. When they do run together it is not with the flowing curves seen in the ripple marks. But an analysis of the difference between the two phenomena really blurs the vividness of the intuitive distinction perceived by direct inspection. The character of the surface exposed when the laminæ are laid bare along their partings is much more like that of slickensides or of

stylolitic joints or of glacial fluting. There is no doubt whatever in my mind that *these partings represent shearing planes and that they have been produced by differential motion of the layers which they separate.*

What may have caused such shearing is a question difficult to answer. Local creeping appears to be the least far-fetched explanation. On steep and high slopes the ground sometimes slowly yields to gravity and moves forward and downward on an inclined plane. The horizontal ingredient in such motion is more or less vertical to the "strike" of the slope. Observations on the trend of these flutings soon brought out the fact that this bore no relation whatever to local or minor topographic features. Their direction maintains itself with only small variations for short distances, and at some places, apparently for miles, irrespective of local topography. Thus at Council Bluffs, in Kane township, in Norwalk, Booner, and Neola townships, the bearings of the flutings are respectively 60° , 65° , 70° , and 75° west of south and east of north. At the latter place, near Neola, it is variable, 70° , 75° , 78° west of south and east of north having been noted within a distance of twenty rods in the west part of the village. East of the town it is 10° north of west. For the next five miles east this direction prevails, three points showing a trend of 8° , 5° , and 20° north of west, all in Minden township. East of this the trend is again to the southwest, except at a point three miles northeast of Avoca, where it is west 45° north and east 45° south. On opposite sides of a hill or of a valley, it seems from some observations that the direction is the same, whether it be parallel, vertical, or at any other angle with the local relief contours.

The general trend of the flutings may be said to be from the northeast to southwest. This generalization is based on observations made at only fifteen localities, which are scattered over a territory thirty-six miles from west to east and fifteen miles from north to south. This seems an insecure and insufficient basis from which to draw the conclusion that the flutings have been produced by general movements of the loess in the direc-

tion indicated. Still this suggests itself as an alternative hypothesis, and it should be kept in mind, pending further investigation. The trends of the flutings are by no means more variable than the trends of ice scorings produced by glacial movements (see Fig. 2).

To account for such a general motion, which conceivably may have been very small, two different hypotheses suggest themselves: (1) Tundra conditions may have prevailed. On a slop-

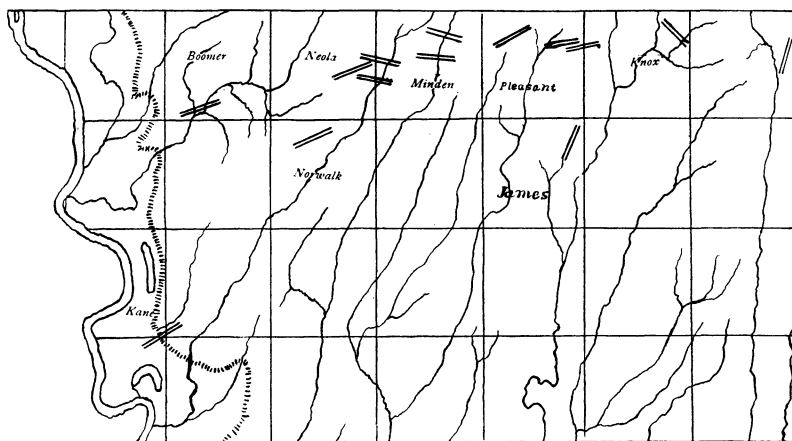


FIG. 2.—Map of Pottawattamie county, Iowa, showing the locations and the directions of flutings observed in the loess.

ing plain the annual temperature changes in a frozen tundra land would be apt to produce extensive creeping in the direction of least resistance, as toward a river. This would, no doubt, result in differential motion near the base of the frozen ground. (2) There may have been glacial conditions. With a sudden onset of arctic climate the area of accumulation of snow might extend far out beyond the margin of the ice pushing out from the region of greatest accumulation, and were the most severe climate not of too long duration, the main continental glacier might come short of extending over all of such extra-marginal and perennial fields of snow. There might then be an extra-morainic névé. Perhaps a certain distribution of precipitation might favor such

results. Over a snow-covered region of this kind there would be ideal conditions for loess-making. A slow creeping of the entire field might very well be supposed to take place in the direction of the general slope of the land.

It is not my desire to discuss these possibilities here. The object of this communication is merely to call attention to this new feature of the loess, and, if possible, thereby to secure more observations on its occurrence.

J. A. UDDEN.

AUGUSTANA COLLEGE,
Rock Island, Ill.